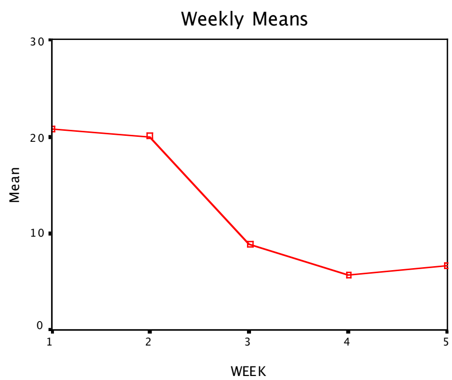
Chapter 18—Repeated-Measures Analysis of Variance

18.1 Descriptive statistics on study of migraines:

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
WEEK1	9	7.0	30.0	20.778	7.1725
WEEK2	9	4.0	33.0	20.000	10.2225
WEEK3	9	5.0	14.0	9.000	3.1225
WEEK4	9	1.0	12.0	5.778	3.4197
WEEK5	9	4.0	17.0	6.778	4.1164
Valid N (listwise)	9				



18.3 I would have liked to collect data from students on the use of pain killers and other ways of dealing with migraines. I might also like to have data on stress levels over time so that I could possibly rule out the effects of stress

> Here again we are getting into issues of experimental design, which underlie all meaningful analyses. This design differs from the one in the "suggestions" section of the Resource Manual for Chapter 16. In that design we had separate groups tested at the different times. This could be worked into the discussion.

18.5 Repeated-measures analysis of variance of data used in Exercise 18.4:

Source	***df***	***SS***	***MS***	***F***
Subjects	8	612.00		
Weeks	1	554.50	554.50	14.424
Error	8	302.00	37.75	
Total	17	1159.7		

[$F_{.05}(1,24) = 4.26$]

There is a significant increase in decrease in severity over time. $F = t^2 = 3.798^2 = 14.424$.

18.7 Effect size for Exercise 18.4

We will use the square root of MS_{error} as our estimate of the standard deviation, because this is a standard deviation corrected for any differences due to subject effects.

$$\hat{d} = \frac{\overline{X}_0 - \overline{X}_3}{\sqrt{MS_{error}}} = \frac{20.00 - 9.00}{\sqrt{10.22}} = \frac{11.00}{3.20} = 3.44$$

The decrease in severity from baseline to training a reduction of approximately three and one half standard deviations. (I used the standard deviation of the baseline scores in line with what I said in the text.)

18.9 $\hat{d}$ for difference in Exercise 18.8

I would standardize the difference in means using the square root of the average of the variances of the two baseline measures. This would leave individual differences as part of the standard deviation, which seems appropriate. The average variance is 77.97, so the standard deviation is 8.83

$$\hat{d} = \frac{\overline{X}_{baseline} - \overline{X}_{training}}{s} = \frac{20.39 - 7.19}{8.83} = \frac{13.20}{8.83} = 1.49$$

On average, the severity of headaches decreased by nearly 1.50 standard deviations from baseline to training.

18.11 *R* analysis of Exercise 18.10

```
data.BST <-
read.table("http://www.uvm.edu/~dhowell/fundamentals9/DataFiles/Ex18-
10.dat", header = TRUE)
attach(data.BST)
dv <- c(Pretest, Posttest, FU6, FU12)
time <- rep(1:4, each = 10)
subject <- rep(1:10, 4)
time <- factor(time)
subject <- factor(subject)
cat("\nTrial Means \n")
tapply(dv, time, mean)
cat("\nSubject Means \n")
tapply(dv, subject, mean)
BSTmodel <- aov(dv ~ time + Error(subject/time))
print(summary(BSTmodel))
```

Result

```
Error: subject
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals  9   3318   368.7


Error: subject:time
          Df Sum Sq Mean Sq F value Pr(>F)
time       3  186.3   62.09   1.042   0.39
Residuals 27 1609.0   59.59
```

18.13 It would appear that without the intervention, condom use would actually have declined. This suggests that the intervention may have prevented that decline, in which case that non-significant result is actually a positive finding.

18.15 Bonferroni *t* tests to compare the beginning and end of Baseline, and the beginning and end of Training for the data in Table 18.1. We can use a standard *t* test because the error term has been corrected by the repeated-measures analysis of variance, which has already removed between subject variability.

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	WEEK0 - WEEK6	-2.680	2.6727	.5345	-3.783	-1.577	-5.014	24	.000
Pair 2	WEEK0 - WEEK12	-3.040	2.9928	.5986	-4.275	-1.805	-5.079	24	.000
Pair 3	WEEK3 - WEEK12	-1.600	2.8868	.5774	-2.792	-.408	-2.771	24	.011

The Bonferroni alpha level would be .05/3 = .01667

We will reject all of the null hypotheses because each *p* value is less than .0167.

18.17 SPSS analysis of data I Table 18.14

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Sphericity Assumed	962.450	3	320.817	2.411	.077
	Greenhouse-Geisser	962.450	2.424	397.003	2.411	.091
	Huynh-Feldt	962.450	2.985	322.482	2.411	.077
	Lower-bound	962.450	1.000	962.450	2.411	.138
Time * Group	Sphericity Assumed	1736.300	3	578.767	4.350	.008
	Greenhouse-Geisser	1736.300	2.424	716.210	4.350	.014
	Huynh-Feldt	1736.300	2.985	581.772	4.350	.008
	Lower-bound	1736.300	1.000	1736.300	4.350	.052
Error(Time)	Sphericity Assumed	7184.250	54	133.042		
	Greenhouse-Geisser	7184.250	43.637	164.636		
	Huynh-Feldt	7184.250	53.721	133.732		
	Lower-bound	7184.250	18.000	399.125		

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	29414.450	1	29414.450	46.795	.000
Group	168.200	1	168.200	.268	.611
Error	11314.350	18	628.575		